SECTION 16269

ADJUSTABLE FREQUENCY AC CONTROLLERS

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LANL MASTER CONSTRUCTION SPECIFICATION

When editing to suit Project, author shall add job-specific requirements and delete only those portions that do not apply to the Project (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the Engineering Standards Manual (ESM) Electrical POC. Refer to http://www.lanl.gov/f6stds/pubf6stds/engrman/HTML/poc_techcom1.htm for the Engineering Standards Manual Personnel Link Index.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within "stars" during editing.

Specification developed for ML-3 / ML-4 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

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PART 1 GENERAL

1.1 SECTION INCLUDES

A. Configured adjustable frequency AC controllers (AFCs) for use with NEMA B design AC squirrel cage induction motors.

1.2 LANL PERFORMED WORK

A. None

1.3 SUBMITTALS

A. Submit the following in accordance with Section 01330, *Submittal Procedures*:

1. Catalog Data: Submit catalog data describing each type of AFC. Include data substantiating that materials comply with specified requirements. Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

2. Calculations: If the total connected kVA of AFCs exceeds 15 percent of the self-cooled kVA rating of the facility service transformer submit evaluation of harmonic distortion at the point of common coupling (PCC) using computer simulation of the distribution system and connected AFCs. The PCC for voltage distortion shall be at the secondary of the utilization voltage service transformers. The PCC for current distortion shall be at the primary of the utilization voltage service transformers. Use procedures outlined in IEEE 519-1992, *IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems*. Assume that all connected AFCs operating at 80% speed.

3. Shop Drawings: Submit shop drawings for each AFC including dimensioned plans and elevations and component lists. Include front and side views of enclosure showing overall dimensions, enclosure type, enclosure finish, unit locations, and conduit entrances.

4. Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, installation, and starting of Product.

5. Operation and Maintenance Instructions: Submit operation and maintenance instructions.

6. Test Reports: Submit results of required factory tests.

7. Warranty: Provide a 3-year parts warranty, on materials and workmanship, and 1-year labor warranty from the date of field certification by manufacturer's representative of satisfactory operation. The manufacturer's turn around period to repair or replace the AFC shall be no more than 48 hours.

1.4 QUALITY ASSURANCE

A. Comply with the *National Electrical Code* (NEC) for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

C. Comply with the applicable requirement of the latest NEMA ICS 3.1 – Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems, IEEE 519, and FCC Part 15 Subpart J.

D. The manufacturer of the AFC shall be a certified ISO 9001 facility.

E. Perform the following factory tests on each AFC:

1. Test every power converter (a component of the AFC) with an actual AC induction motor 100% loaded and temperature cycled to the full range of the AFC. Monitor the power converter for correct phase current, phase voltages, and motor speed. Verify current limit operation by simulating a motor overload.

2. Verify proper factory presets by scrolling through all parameters to ensure proper microprocessor settings. Verify proper functioning of all input and output ports.

3. Test all AFC door mounted pilot devices to verify proper function.

4. Functionally test all options including operation of a motor in the bypass mode if supplied. Verify proper setting of motor overload protection.

5. Test the AFC wiring for continuity, shorts, and unintended grounds with all enclosed devices mounted and wired.

1.5 RECEIVING, STORING AND PROTECTING

A. Receive, store, and protect, and handle products according to NECA 1—*Standard Practices for Good Workmanship in Electrical Construction*.

1.6 EXTRA MATERIALS

A. Furnish six spares of each size and type fuse required.

B. Provide one spare AFC printed circuit board of each type used.

C. Provide three spare power semiconductors of each type used.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Alternate products may be accepted; follow Section 01630, *Product Options and Substitutions.*

2.2 ADJUSTABLE FREQUENCY AC CONTROLLER

A. Provide UL508 listed and labeled configured adjustable frequency AC controller(s) (AFC) as indicated on the Drawings and specified in this Section.

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Edit the following article to match project requirements.
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B. Each configured AFC shall be an integrated assembly with an externally operated disconnect device, current-limiting fuses, line input reactor, power converter, cooling fans, operator interface, control system interface, control power transformer, [input contactor,] [bypass contactors,] and a suitable enclosure.

C. Provide fusible switch type externally operable disconnect. Disconnect handle shall have provisions for locking in the OFF position with up to 3 padlocks. Mechanical interlocks shall prevent opening the enclosure door with disconnect in the ON position and shall prevent moving disconnect to the ON position with enclosure door open.

D. Provide current-limiting drive branch circuit fuses in the disconnect switch. Select fuses to protect the input rectification circuit. Use Class J fuses with interrupting rating of 200,000 AIC. The series interrupting rating of the AFC and fuses shall be a minimum of 30,000 AIC and shall be stated in the AFC Instruction Manual as required by UL

E. Provide a three phase 3% impedance input line reactor in the AFC cabinet to minimize drive harmonics on the AC line and protect the drive from damaging electrical system transients. Provide additional input filtering as required to limit line current total harmonic distortion (THD) to less than 10 percent.

F. Provide power converter that is microprocessor based using insulated gate bipolar transistors and pulse width modulation (PWM) technology and is suitable for low-noise operation of adjustable torque loads such as centrifugal pumps and fans.

1. Input voltage shall be either 200-230 or 380-480 VAC as indicated on the drawings.

a. Power converter shall be able to withstand voltage variations of -15 percent to +10 percent and imbalance of 3 percent without tripping or affecting drive performance.

b. Power converter shall operate with input frequency of 60 Hz and shall withstand a frequency variation of +5 percent to -5 percent.

c. Power converter displacement power factor shall be not less than 0.95 lagging under any speed or load condition.

d. The efficiency of the power converter shall be not less than 96 percent at full speed and full load.

e. Line notches, transients, and harmonics on incoming line shall not affect power converter performance.

f. Power converter shall include provisions for a DC link inductor. Power converters 100 HP and above shall be supplied with DC link inductor.

2. Power converter output shall be capable of continuously operating the connected variable torque motor load over the complete speed range at an elevation of 7500 feet in an ambient temperature of +40 degrees C.

a. Current rating of the power converter shall be based on a carrier frequency of 8 kHz for AFCs 1-75 HP and 4 kHz for AFCs 100-400 HP. All HP ratings shall meet or exceed Table 430.150 of the National Electric Code. Rated three-phase motor full load current, HP, maximum current and rated voltage shall appear on the power converter nameplate.

b. Power converter output voltage shall vary with frequency to maintain a constant volts/hertz ratio up to 60 Hz output. Constant or linear voltage output shall be provided above 60 Hz.

c. Power converter rated output voltage shall be programmable to match motor nameplate voltage.

d. The power converter one-minute overload rating shall be not less than 110 percent of rated current, adjusted for altitude.

e. The power converter shall be able to operate with its output disconnected for troubleshooting and startup.

f. PWM carrier frequency shall be field adjustable with a minimum range of 2 kHz to 6 kHz to minimize the level of audible motor noise.

g. Motor acceleration and deceleration shall be programmable.

h. For fan service, provide controller with not less than 3 programmable critical frequencies that can be skipped to avoid mechanical resonances.

i. Power converter shall not generate damaging voltage pulses at the motor terminals when located within 200 feet of the motor. Power converter shall comply with NEMA MG1 section 30.40.4.2.

3. Supply the power converter with interface modules as required to provide the following control functions and external signals:

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Edit the following article to match project requirements. Provide interface compatible with the building automation system. Delete if not needed.

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a. Automatic control using ANSI/ASHRAE Standard 135, ISO 16484-5 approved BACnet compatible communications from the building automation system. This communications port shall provide direct communication between the drive microprocessor and the building automation system. All configuration and control functions shall be accessible through this port and fault diagnostics, start/stop, speed commands, and all drive feedback variables shall be available. Discrete signals such as Bypass Run or Interlock Open shall also be mapped through the drive terminal strip to the system for unitary control. The communications port shall have the ability to be used in a "monitor only" mode where control shall be from a digital controller directly wired to the drive.

b. Six configurable digital inputs, factory pre-set for common HVAC control interface to minimize customization at start up.

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Edit the following article to match project requirements.

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c. Two isolated analog inputs with 0-20 mA, 4-20 mA or 0-4 V, 0-8 V, and 0-10 V selectable parameters. Both shall be capable of providing speed feedback for internal PI setpoint control loop. Either may be mapped to communication port for unitary control of temperature, pressure, or other analog control functions.

d. Isolated 0-10 V output signal proportional to speed or load as required to interface with control system

e. Not less than two sets of NEMA ICS 2 field-convertible auxiliary contacts to signal the following conditions:

1) Drive run.
2) Drive fault.

4. Provide the power converter with the following protective features:

a. Class 10 or 20 electronic overload circuit designed to protect AC motor operated by the AFC output from extended overload operation. No additional hardware such as motor overload relays or motor thermostats shall be required.

b. Output phase-to-phase short circuit protection.

c. Output ground fault protection.

d. High input line voltage.

e. Low input line voltage.

f. Loss of input or output phase.

g. Drive overcurrent.

h. Drive over-temperature.

i. Stall protection.

j. Transient voltage surge suppression up to 6000 volts peak per IEEE C62.41.

k. The power converter shall automatically restart after a momentary power interruption.

G. Provide the following operator interfaces mounted on the cover of the AFC:

1. Touch keypad and LCD screen that digitally indicates:

a. Frequency output

b. Voltage output

c. Current output

d. Motor RPM

e. Motor kW

f. Elapsed Time

g. Time Stamped Fault Indication

h. DC Bus Volts

i. Faults

j. PI running, PI setpoint

k. Parameter settings

2. Heavy duty, 22 mm or 30 mm, metal operator, oil tight pilot devices as listed below with NEMA ICS 2, Form Z, A600 rated contacts:

a. Push buttons: Mushroom head, maintained action, turn-to-release emergency STOP pushbutton.

b. Push-to-test LED type indicating lights:

1) White POWER ON pilot light.
2) Yellow FAULT pilot light.
3) Red RUNNING pilot light.
4) Green STOPPED pilot light.

c. Speed Control Selector Switch: Rotary type LOCAL - OFF - REMOTE.

3. Provide legend plates for pushbuttons, pilot lights, potentiometer, and selector switch.

H. Provide labeled terminal block connections for safety interlocks, fault contacts, normal operational functions such as run/stop, remote references, mode control, external emergency stop, and external emergency full-speed.

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Edit the following article to match project requirements. Specify bypass for systems serving safety class, life safety, or mission critical loads.

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I. Provide the AFC with 3-contactor isolation and bypass system.

1. Provide interlocked isolation and bypass contactors, electronic overload relay, fused disconnect interlocked with the door, motor flux decay timer and AFC-TEST-BYPASS selector switch.

a. In the AFC position the power converter shall provide adjustable frequency speed control of the motor under non-fault conditions. When the power converter is under a fault condition the contactors shall be automatically energized upon power converter shutdown (Drive fault contact operation) to isolate the power converter and operate the motor, across the line, on 60 Hertz line power through the overload relay.

b. In Drive Test mode, the drive-input contactor shall be closed to keep the power on to the drive, and the drive-output contactor open. This shall enable the user to test the drive before running the motor. A jumper shall be added to test the drive while bypass is running the motor and must be field installed to alert operators of this condition.

c. In bypass mode, the drive-input and the drive-output contactor will be open to isolate the drive. The bypass contactor will be open to allow the motor to run directly from the AC line. Bypass motor overload protection shall be provided by electronic Class 20 adjustable overload relay.

2. Provide relay control logic within the AFC enclosure to allow the same "START/STOP" and “EMERGENCY STOP” commands to operate the motor in either the AFC or BYPASS mode.

3. Provide push-to-test LED indicator lights to annunciate bypass status and alarms.

J. Provide a control power transformer in each enclosed AFC. The transformer shall have 120-volt secondary and sufficient capacity to operate all connected cooling fans, pilot, indicating and control devices, plus 100 percent spare capacity. Provide fused primary and secondary. Bond un-fused leg of secondary to enclosure. Provide fuse blown indicating fuses.

K. Provide auxiliary control relays where required to accomplish interlocks and control sequences. Relays shall be heavy-duty general-purpose type, having 115 volt 60 Hertz operating coils.

L. Provide the AFC with cooling air fan(s) and/or heat sink construction as required for maintaining the temperature of components within operating limits. Provide filtration for cooling air as required for the installation and operating environment.

M. Provide AFC enclosure in accordance with ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems as required to meet conditions of installation and operation.

N. Manufacturer: Allen-Bradley “1336 Plus II”, ABB “ACS 550”, GE-Fuji “AF-300 P11”, Square D “ATV66”.

PART 3 EXECUTION

3.1 EXISTING WORK

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Delete this article when existing construction is not affected.

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A. Disconnect and remove abandoned AFCs.

B. Maintain access to existing AFCs and other installations that are to remain active and to require access. Modify installation or provide access panel.

C. Clean and repair existing AFCs that are to remain or be reinstalled.

3.2 EXAMINATION

A. Examine surfaces to receive control equipment for compliance with installation tolerances and other conditions affecting performance of the control system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install motor control equipment where indicated on the Drawings and according to manufacturer's instructions. Manufacturer’s installation instructions shall be available at the construction site.

B. Mount with operating mechanism 5'-0" above floor or as indicated on the Drawings.

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Edit C and D to match the current LANL standard specification numbers. Specifications are being updated in phases during 2004. The first section listed is the current number; the second is the intended future number.

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C. Install enclosed controllers plumb. Provide supports in accordance with the requirements of [Section 16190 *ELECTRICAL SUPPORTING DEVICES*] [Section 16070 *HANGERS AND SUPPORTS*] and the NEC.

D. Ground and bond motor controllers and control devices as required in [Section 16450 *SECONDARY GROUNDING*] [Section 16060 *GROUNDING AND BONDING*].

E. Identify motor controllers and install warning signs as required in Section 16075 *ELECTRICAL IDENTIFICATION*.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not furnished, use those specified in UL 486A.

G. Set overload relays or install overload heater elements in motor controllers to match installed motor characteristics.

H. Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.4 FIELD QUALITY CONTROL

A. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing before energizing motor controllers. Correct any deficiencies before energizing controller.

B. Inspect and test in accordance with NETA ATS. Perform inspections and tests listed in NETA ATS, Section 7.16.1. Correct any deficiencies before energizing controller.

C. Verify proper overloads are installed or set for the motor nameplate full load current and duty.

D. After completing installation, cleaning, and testing, touch up scratches and mars on finish to match original finish.

E. Provide the services of an AFC manufacturer certified technician to including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

END OF SECTION

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Do not delete the following reference information.

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This project specification is based on LANL Master Construction Specification Rev. 0, dated March 29, 2004.